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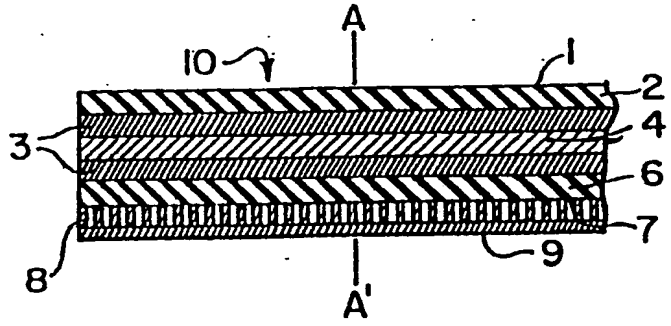

(57) Abstract

There is described an improved electrical wiring including at least one pair of elongate electrically conductive metal foil strips laminated between opposing layers of insulating film by means of adhesive securing the foil strips between the laminating films, whereupon the wiring is generally thin and flat in cross-sectional shape. The wiring may advantageously be formed with a layer of adhesive on an external surface thereof for continuous connection along its length to an external wall.

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ELECTRICAL APPARATUS

DESCRIPTION

TECHNICAL FIELD

This invention relates to improved apparatus for transferring electrical current between a power source and one or more destination devices and more specifically to improved electrical wiring and a method of manufacturing the same.

BACKGROUND ART

When a building is under construction, it is relatively easy to install traditional round wiring and connective devices in such a way as to hide the wire inside or behind walls, floors, ceilings, partitions, etc. However, once construction has been completed, if there is a desire or need to install additional devices and wiring, the process of hiding the wiring can be very complex, time consuming and expensive. Alternatively, the wire can be left exposed where it can be visually offensive or hazardous. Where round cross-sectional wire is placed against a surface, its profile in a direction perpendicular to the surface makes its presence visually obvious and provides an obstacle which may be caught by passing objects. Further, loose wiring may be attractive to manipulation by children or animals, and may lead to strangulation or electrocution. Further, round cross-sectional wire has previously been attached to a surface only at specific points by separate holding devices, wherein the wire is not attached to the surface between these holding devices. Further, round cross-sectional wire is not of a suitable configuration to permit continual secure adhesion to a surface through the use of pressure sensitive adhesive.

Hitherto it has been preferred to transmit electric current by way of metal wire having a roughly circular cross-section, or through a series of such wires formed of strands of metal of roughly circular cross-sections twisted

together to form a larger wire conductor having a roughly circular cross-section. Such wire is ordinarily formed by forcing molten metal through an extrusion die of roughly circular opening and rapidly cooling the metal to a solid state, retaining a roughly circular cross-section. Terminal connectors for such circular cross-sectional wire have been designed for various purposes.

Where round wire has been electrically insulated, the method has normally required the metal wire to be drawn through an extrusion die coating process where insulating material in liquid form is poured over round wire. The liquid insulating material subsequently thickens to a more solid form. Inconsistencies in wire and insulation thicknesses have required additional insulation to compensate for those inconsistencies. We have found that the disadvantages presented by wire of generally circular cross-sectional shape may be overcome by using electrically conductive flat foil parallel strips laminated within electrically insulating material which on one side has preferably been coated with a strong adhesive for securely and continuously connecting the present conductor to a wall or other surface. The resulting low profile of the combination perpendicular to the wall or other surface permits the combination to be simply hidden or made less conspicuous using paint or other suitable covering material. This method provides less attraction to children and animals and is less visually offensive than exposed round wiring. In some applications, it may be desirable to place images, patterns or instructions directly on the electrical wiring. The subject material is more easily decoratively coated or imprinted than traditional round cross-sectional wire. Additionally, in order to provide the same cross-sectional area as that provided by round wire designed for the same power load, the surface area of the foil conductor is many times larger, providing superior

heat dissipation, and consequently, lower resistance to the equivalent power load. Laminating film can be manufactured to extremely close thickness tolerances and can provide a more consistent insulating coating for foil than can extrusion coating around round cross-sectional wire. Therefore, thinner material can be used and consequently a lower profile can be achieved while providing consistent insulating properties.

Single strand exposed lead foil with a low-tack adhesive has been used on glass to connect burglar alarm devices which are triggered when the glass is broken and the ability of the lead to conduct a monitoring signal is interrupted. Lead has been used because of the ease with which it is broken. It is, however, a very inefficient conductor of electric current. Further, the adhesive used directly on the lead strand has been suitable only for use on clean, dry, non-porous surfaces. Further, the lead strand has not been laminated within a non-conductive, non-porous insulating film. Such a film would add strength to such lead strips and as such the lead strips might not break when the alarm protected glass is broken. As the present configuration of lead and adhesive cannot be adhered to porous surfaces, such as wood, paint, plaster and drywall, it is limited in its applications. As lead is a very poor conductor of electricity, it is not suitable for supplying electric current to many devices, particularly over long distances.

Single strands of metal have been adhesively coated. However, it is extremely difficult to install multiple strips of single strand material in parallel to one another, maintaining consistent separation. The invention provides a carrier laminate film to maintain consistent spacing of the individual strands so that an electrical short circuit will not be created and connective devices will fit as designed.

DISCLOSURE OF INVENTION

It is therefore an object of the present invention to obviate and mitigate from the disadvantages of the prior art.

It is a further object of the present invention to provide electrically conductive wiring using generally flat strips laminated within an insulating carrier.

According to the present invention, then, there is provided electrical wiring comprising at least one pair of elongate spaced apart electrically conductive foil members, electrically insulating laminate film means disposed on opposite sides of said foil members, and adhesive means securing said foil members between said laminate film means, wherein said wiring is generally flat in cross-sectional shape.

According to a further aspect of the present invention, there is also provided a method of manufacturing laminated electrical wiring comprising the steps of splitting an electrically conductive foil into a plurality of continuous strips, separating said strips by a predetermined distance so as not to be in electrical contact with one another, laminating said strips between opposing layers of insulating film to thereby form a laminate, and cutting said laminate into predetermined lengths for rolling onto storage means.

BRIEF DESCRIPTION OF DRAWINGS

Preferred embodiments of the present invention will now be described in greater detail and will be better understood when read in conjunction with the following drawings in which:

Figure 1 is a side elevational sectional view of the present wiring;

Figure 2 is a cross-sectional view of the wiring of Figure 1 along the line A-A';

Figure 3 is a side elevational sectional view of a modification to the wiring of Figure 1;

Figure 4 is a cross-sectional view of the wiring of Figure 3 along the line B-B';

Figure 5 is a side elevational sectional view of another modification to the wiring of Figure 1;

Figure 6 is a cross-sectional view of the wiring of Figure 5 along the line C-C';

Figure 7 is a side elevational sectional view of the wiring of Figure 1 including RF shielding;

Figure 8 is a cross-sectional view of the wiring of Figure 7 along the line D'-D; and

Figure 9 is a schematical representation of a process for manufacturing the present wiring.

BEST MODE FOR CARRYING OUT THE INVENTION

With reference to Figures 1 and 2, wiring 10 comprises at least one but more usually a pair of parallel, spaced apart electrically conductive foil strips 4 secured between upper and lower electrically insulating laminate films 2 and 6, respectively, by means of a suitable adhesive 3. Adhesive 3 is chosen to be stable at temperatures well in excess of the designed operating temperature of wiring 10, and should advantageously adhere more strongly to laminate films 2 and 6 than to foil strips 4. This will facilitate separation of foils 4 from films 2 and 6 when stripping for electrical connection is required.

Upper surface 1 of laminate film 2 is preferably treated, textured or coated in any suitable known way so as to readily permit paint or other coating material to adhere thereto for hiding or decorating purposes.

For purposes of adhering wiring 10 to an external surface such as the wall of a room or building, the lower surface 7 of lower film 6 may be advantageously coated with a strong pressure-sensitive adhesive 8 which will adhere to a wide range of surfaces. Below this may be placed a layer

of temporary release material 9 such as a strip of waxed paper, which will prevent the pressure-sensitive adhesive 8 on lower surface 7 from adhering to itself or other objects until the wiring is transferred to its destination.

Conductive foils 4 may be of any suitable material but copper or silver or alloys thereof are preferred having regard to their conductivity, malleability and their other well known characteristics. Aluminum may in some instances be useful, particularly for RFI (radio frequency interference) shielding as will be described with reference to Figure 7. Laminate films 2 and 6 may be a non-porous polyester hydrocarbon such as that known commercially as MYLAR (trade-mark). A wide range of adhesives is available for adhesive 8. Obviously, the adhesive chosen should be of sufficient bonding strength to meet the required application specifications with consideration to such matters as temperature exposure, both internally generated and ambient, surface conditions and exposure to ambient moisture and gases.

As will be appreciated, foils 4 and laminate films 2 and 6 are generally rectangular in cross-sectional configuration such that wiring 10 itself presents a relatively thin, flat profile to facilitate concealment and connection to the surface of a wall, etc. The views of the wiring in the drawings appended hereto are considerably exaggerated for purposes of more clearly illustrating the composition and structure of the wiring. In practice, foils 4 will normally be .003" to .005" thick in widths ranging from .125" to .25" depending upon the equivalent American Wire Gage standards for cross-sectional area of rounded wire. Films 2 and 6 will typically vary in thickness from .0015" to .003". In one embodiment contemplated by the applicants, there will normally be a 1/16" spacing from the outer edge of each foil to the outer

edges of film 2 and 6, and the foils themselves will be spaced approximately ,125" apart.

With reference to Figure 9, where like numerals are used to identify like elements shown in Figures 1 and 2, the process of manufacturing wiring 10 begins with preparation of the laminating film 2 and 6. Flexible electrically insulating film 2 may be prepared with surfaces suitably treated, textured or coated so as to permit adhesion of paint or other coating material. Film 2 may be dyed in the process of manufacture. One surface of film 2 is coated with a suitable adhesive 3, which will adhere to metal foil 4 and to second laminate film 6 treated with a compatible adhesive.

Second laminate film 6 is similarly prepared and coated with adhesive 3. The outer opposing surface 7 of film 6 may be advantageously coated with a suitable high tack pressure sensitive adhesive 8, which will adhere to the intended destination surface. The high tack pressure sensitive adhesive may then be covered with a suitable release material 9 to prevent self-adhesion.

From a roll 12, a strip of metal foil 4 of predetermined width, thickness and composition is passed through rotary cutter 14 as roll 12 is unwound to split foil 4 into strips of predetermined width. The strips are spread apart a suitable distance by means of spacers 18 and 19.

The strips of foil 4 are then contacted to adhesive 3 on laminating film 6 from a roll 40 of such film, and passed between pressure rollers 20 which may or may not be heated, depending upon whether adhesive 3 is heat-activated. Continuing, laminating film 2 from a roll 45 of such film is then contacted to the exposed upper surface of foil 4, so that adhesive side 3 will contact the foil 4 and the adhesive on the laminating film 6. The combination is then passed between pressure rollers 22, which may or may

not be heated, as discussed above. The combination has now been laminated into a single unit.

The combination may then itself be slit such as by means of a rotary cutter 50 along its length into separate wiring tapes each having preselected numbers of conductors therein. The tapes so formed may then be cut using a cutter 60 into appropriate lengths and wound onto cores 70 ready for installation.

Installation is accomplished on site by removal, if appropriate, of the temporary covering layer 9 and pressing the pressure-sensitive adhesive side of the laminate/foil combination against the receiving surface.

Where terminals, splices and other connections are desired, the exposed insulating film is lightly cut and pealed back to expose the metal foil. Connecting devices may then be soldered and/or friction contacted and/or perforation contacted and/or adhesive contacted with electrically conductive adhesive to the conductive foil. Where perforation contact only is used, the laminate need not be removed as the perforating object may penetrate the laminate and directly contact one or more foil conductors.

The wiring so formed has many advantages. As the combination is adhered tightly and continuously to a fixed surface and is of very low profile in a direction perpendicular to that surface, there is less likelihood the conductor will be caught by passing objects or become attractive to manipulation by children, or animals. Further, the combination is easily concealed under paint or other covering material and is therefore less visually offensive. Further, such a combination, by being more easily concealed, may provide greater security from detection. Further, the foil profile presents a larger exposed surface cooling area than standard round wire of the same cross-sectional area. Further, by spreading resistive heat generated by electric current over a larger

area than does a round cross-sectional wire of equivalent load capacity, there is less likelihood of damage to the attachment surface or covering materials, such as, but not limited to, paint or wallpaper.

Alternative configurations are also the subject of this invention. In certain applications, as in Figures 3 and 4, it may be desirable to eliminate upper laminate film 2 in order to expose metal foil 4 along its entire length. In such a case, foil 4 would be bound solely to lower laminate film 6 by adhesive 3. The foil can be pre-coated with adhesive prior to slitting in the manufacturing process.

In some applications, as in Figures 5 and 6, it may be desirable that the wiring not be externally adhesive and adhesive layer 8 and release sheet 9 may be eliminated.

In other applications, multiple layers of wiring 10 may be superimposed on one another to provide a wiring harness configuration.

Foil 4 may itself be coated with a further material, such as, but not limited to tin, to aid in connection to other electrical devices.

It is further contemplated that conductive foil 4 may, in some applications, act as a fuse and comprise a conductive material of sufficiently low melting point as to suit this purpose. The fuse function may be based on the electrical current load wherein excessive current will cause the foil to melt and break. It may also be used where the ambient temperature from an external source rises beyond the designed melting point of the foil. In such an application, the foil itself could act as a continuous temperature sensor. It is known that an increase in the temperature of a conductor also increases its electrical resistance. Monitoring of such fluctuations in electrical resistance of the foil circuit could be used in alarm and control applications.

The top surface 1 of film may as aforesaid be configured to accept a variety of coating materials, such as, but not limited to, paint, wallpaper adhesive, or printing ink. This would permit easy concealment of the combination or permit decorative designs or instructions to be placed on the combination.

Laminate film 2 may be clear or may be coloured with a suitable dye material and may be treated to reflect or diffract light.

With reference to Figures 7 and 8, RF shielding of foils 4 may be provided by additional sheet-like foils 30 and 31 above and below foils 4.

Splicing breaks in the wiring can be accomplished by using foil strips coated on one side with electrically conductive adhesive and placing the splicing strip across the break. Alternatively, breaks can be soldered or mechanically joined.

Connecting devices (not shown) can directly contact the electrically conductive foil or an electrically conductive adhesive can be placed between the connecting device and the foil.

Further and additional adaptations and modifications of the present invention will occur to those skilled in the art and such may fall within the spirit and scope of the invention as defined in the claims appended hereto.

CLAIMS:

1. Electrical wiring comprising at least one pair of elongate spaced apart electrically conductive foil members;

electrically insulating laminate film means disposed on opposite sides of said foil members; and

adhesive means securing said foil members between said laminate film means, wherein said wiring is generally flat in cross-sectional shape.

2. The wiring of claim 1 further including on an outer surface of said laminate film means a layer of adhesive for securing said wiring to a receiving surface.

3. The wiring of claim 1 characterized in that said adhesive means bonds to said laminate film means with greater strength than to said foil members to facilitate stripping of said foil members for external electrical connections.

4. The wiring of claim 2 characterized in that an outer surface of said laminate film means opposite said surface thereof having said layer of adhesive thereon is adapted to receive a decorative coating thereonto.

5. The wiring of claim 3 including a plurality of layers alternating between said foil members and said laminate film means including said adhesive means bonding said layers together.

6. The wiring of claim 3 including a layer of conductive foil disposed on opposite outer surfaces of said laminate film means to provide radio frequency shielding of said foil members, and further including additional electrically

insulating laminate film means disposed on opposite outer surfaces of each said layer of conductive foil.

7. A method of manufacturing laminated electrical wiring comprising the steps of:

splitting an electrically conductive foil into a plurality of continuous strips;

separating said strips by a predetermined distance so as not to be in electrical contact with one another;

laminating said strips between opposing layers of insulating film to thereby form a laminate; and

cutting said laminate into predetermined lengths for rolling onto storage means.

8. The method of claim 7 including the additional step of applying pressure sensitive adhesive to an outer surface of one of said layers of insulating film.

9. The method of claim 7 characterized in that said laminate is cut along the length thereof to form said laminated electrical wiring having at least one pair of said continuous foil strips in each length thereof.

10. The method of claim 9 characterized in that said foil strips and said layers of insulating film are laminated together using adhesive applied therebetween, the combinations thereby formed being subjected to pressure to complete said lamination.

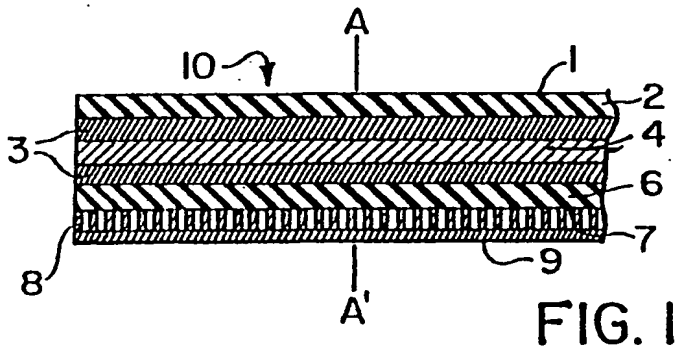

FIG. 1

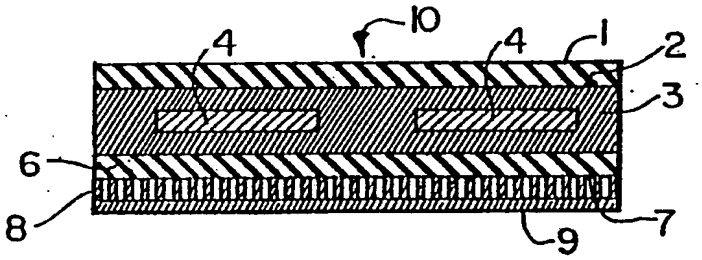

FIG. 2

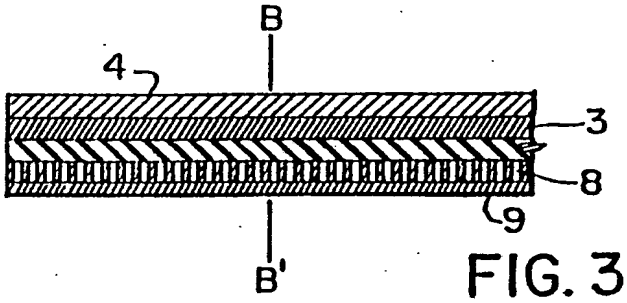

FIG. 3

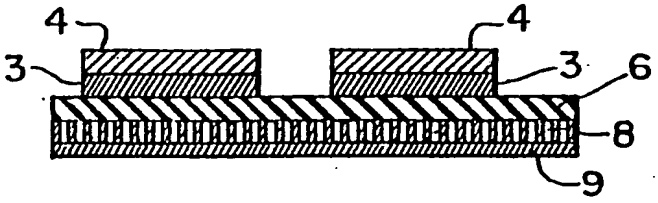

FIG. 4

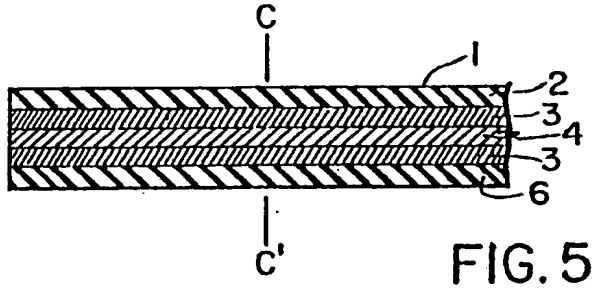

FIG. 5

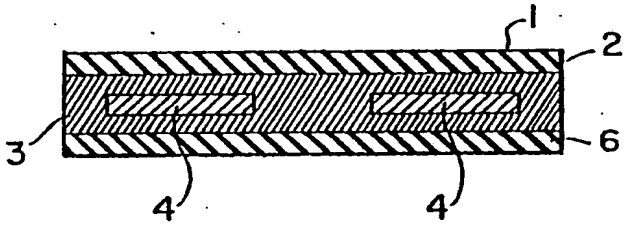

FIG. 6

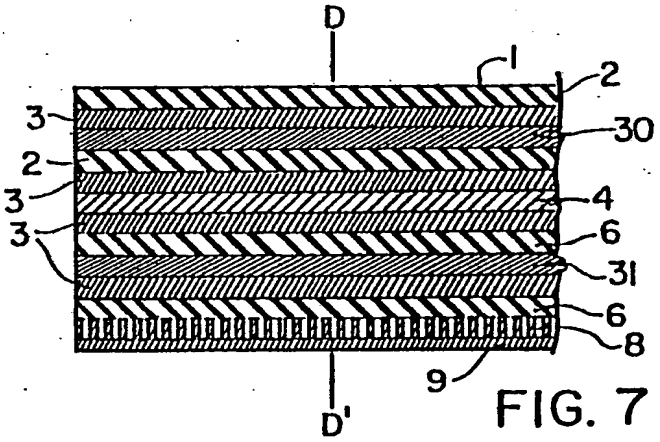

FIG. 7

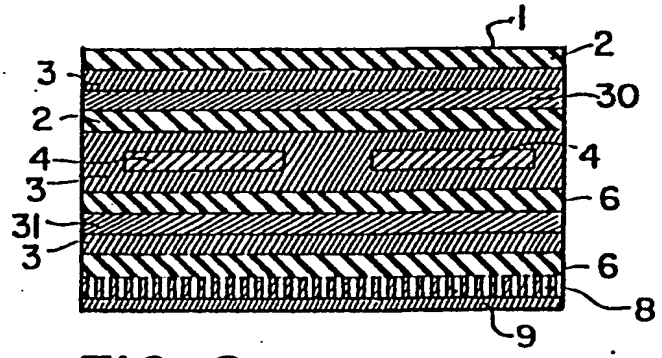

FIG. 8

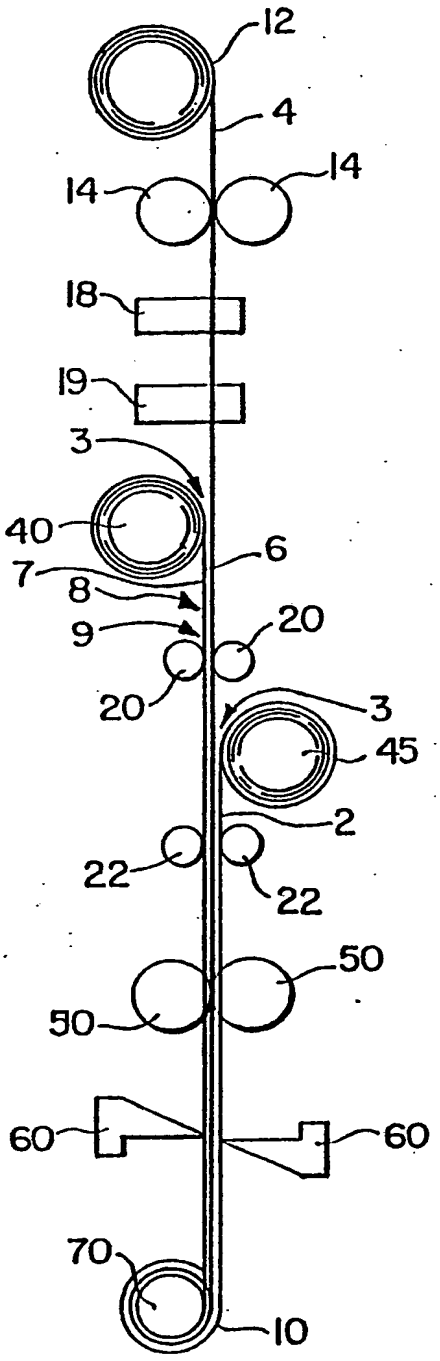

FIG. 9

INTERNATIONAL SEARCH REPORT

International Application No PCT/CA 90/00443

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 H01B7/08

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H01B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	GB,A,1604676 (GRANVILLE BARLOW) 16 December 1981 see page 1, lines 11 - 23	1, 2
A	see page 1, line 91 - page 2, line 7; figures 1, 2	7
X	FR,A,2058670 (BESIGOT) 28 May 1971 see page 2, line 19 - page 3, line 15; figures 1, 2	1, 2, 4
X	NTIS TECH NOTES. no. 11, November 1984, SPRINGFIELD, VA US page 892 "Shielded Aluminum Flat-Conductor Cable" see the whole document	1, 6
X	US,A,3612743 (ANGELE ; KENNEDY) 12 October 1971 see column 2, line 37 - column 5, line 54; figures 1-4	1, 6

° Special categories of cited documents :[10]

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
09 APRIL 1991	16 MAY 1991
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	DEMOLDER J.

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. CA 9000443

SA 42802

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 09/04/91
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A-1604676	16-12-81	None	
FR-A-2058670	28-05-71	BE-A- 754873 CH-A- 522274	18-01-71 30-04-72
US-A-3612743	12-10-71	None	